# PACS/RIS Overview

Alberto F. Goldszal, Ph.D.
Radiologic & Imaging Sciences Program
NIH Clinical Center



# PACS/RIS Def

- PACS = Picture Archiving and Communications Systems; RIS = Radiology Information System
- PACS/RIS  are medical devices, not merely information systems.
- Complex automation systems for acquiring, transmitting, managing, storing and displaying digital diagnostic images and associated text information.
- PACS/RIS systems are the application of information age technology to *improve the quality and efficiency* of radiology services.

# Why PACS/RIS?

- Decrease number of repeated examinations.
- Decrease/eliminate film and chemical costs.
- Decrease turnaround time of exams.
- Improve access to prior studies.
- Improve the quality of images.
- Decrease frequency of misidentified images.
- Improve equipment availability.
- Improve efficiency of after-hours interpretation.
- Improve availability of images and reports.
- Minimize/eliminate lost films.
- Low fat, tastes great!

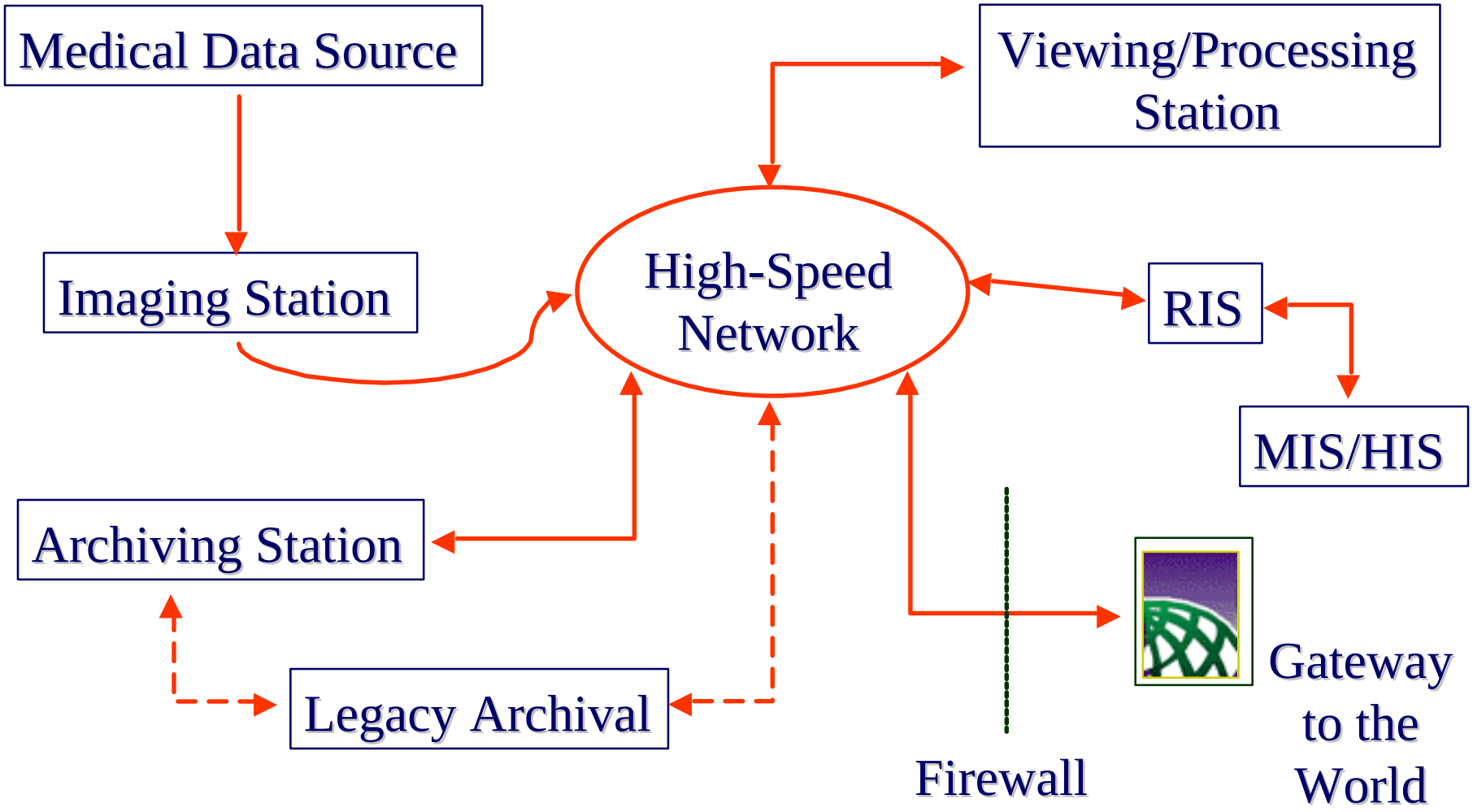
# Additional Motivation f PACS/RIS

- Acquire, distribute and archive images from all medical imaging modalities in digital form;
- Use fast networking for transferring and accessing any part of a patient's file from any location within NIH;
- Reduce the time needed for an examination to become available to the attending and referring physicians;
- Improve medical image interpretation with the use of image processing tools (e.g., multimodality image registration, segmentation, enhancement, etc.);
- Facilitate short- and long-term image and medical data archiving.

# PACS/RIS Design Considerations

- Enable integration of new and existing medical record data including image, biosignal, textual and demographic data toward a filmless and paperless operation;
- Create a digital environment with embedded access security and data safety mechanisms;
- Advanced databasing, processing and diagnosis supportive software tools;
- Extendibility to new equipment additions, network reorganization;
- Support to interhospital data exchange.

# NIH/ISP PACS/RIS Design



# PACS Generations...

- First generation:
  - "Users find the data"
- Second generation:
  - "Data find the devices"
- Third (current) generation:
  - "Information and images find the user"

# PACS Subsystems

- Acquisition Subsystem
- Network Subsystem
- Image Management Subsystem
- Display Subsystem

# Acquisition Subsystem

- Components for acquiring digital radiologic examinations
  - *Film digitizers, computed radiography, direct digital radiography*
- Components for acquiring patient and exam information
  - *Data entry terminals and interfaces to Radiology Information System (RIS)*
- Components for interfacing digital modalities to the network
  - *Network Interface Adaptors (NIAs)*

# Network Subsystem

- Components for maintaining connectivity between acquisition, archive, and display subsystems
- Can be dedicated or shared local area network (LAN), wide area network (WAN), intranet or internet.
- Can be Ethernet, Fast Ethernet, Gigabit Ethernet, ATM, SONET, or proprietary
- Digital Communications in Medicine (DICOM 3.0)
  - *Follows Open Systems Integration (OSI) standard*
  - *Supports TCP/IP and ACR/NEMA*
- Web Technology

# Image Management Subsystem

- Components to receive images from acquisition subsystem
  - *Gateways*
- Components to make recent images immediately available to display subsystem
  - *Redundant Array of Inexpensive Disks (RAID), Web Servers*
- Components to store and retrieve images to intermediate/long term storage
  - *Archive servers, Optical Disk Jukebox (ODJ), Digital Linear Tapes (DLTs)*

# Image Management Subsystem (continued)

- Components to keep track of the location and status of images and to associate text and image information
  - *Image Database*
- Components to retrieve patient data, exam data, and reports from the Radiology Information System (RIS)
  - *RIS Interface*

# Image Display Subsystem

- Components to display and manipulate images
  - *Diagnostic workstations, clinical workstations, quality control workstations, web viewers*
- Components to produce hard-copy images
  - *Laser cameras, dry process laser cameras, high quality paper printers*

# Standard-Based Architecture

- Digital Imaging and Communications in Medicine (DICOM, v3.0) used within PACS
- Health Level 7 (HL-7) interface between medical information systems
- Open Systems Interconnection (OSI) data networks standard
- Open Database Connectivity (ODBC) standard

# NIH/ISP Existing Imaging Configuration

4 CTs

3 MRs

8 MRs @ NMR Ctr / LDRR

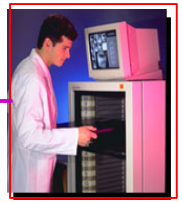
Several Visualization Workstations

1 Fluoro (+1 future)

2 Angio

2 MRs @ Suburban

3 PETs

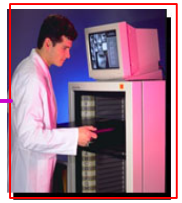


3 CRs

1 DR (+2 future DRs)

5 Nuc Med scanners

6 Ultrasound scanners



2 Mammo units

Legacy Archive

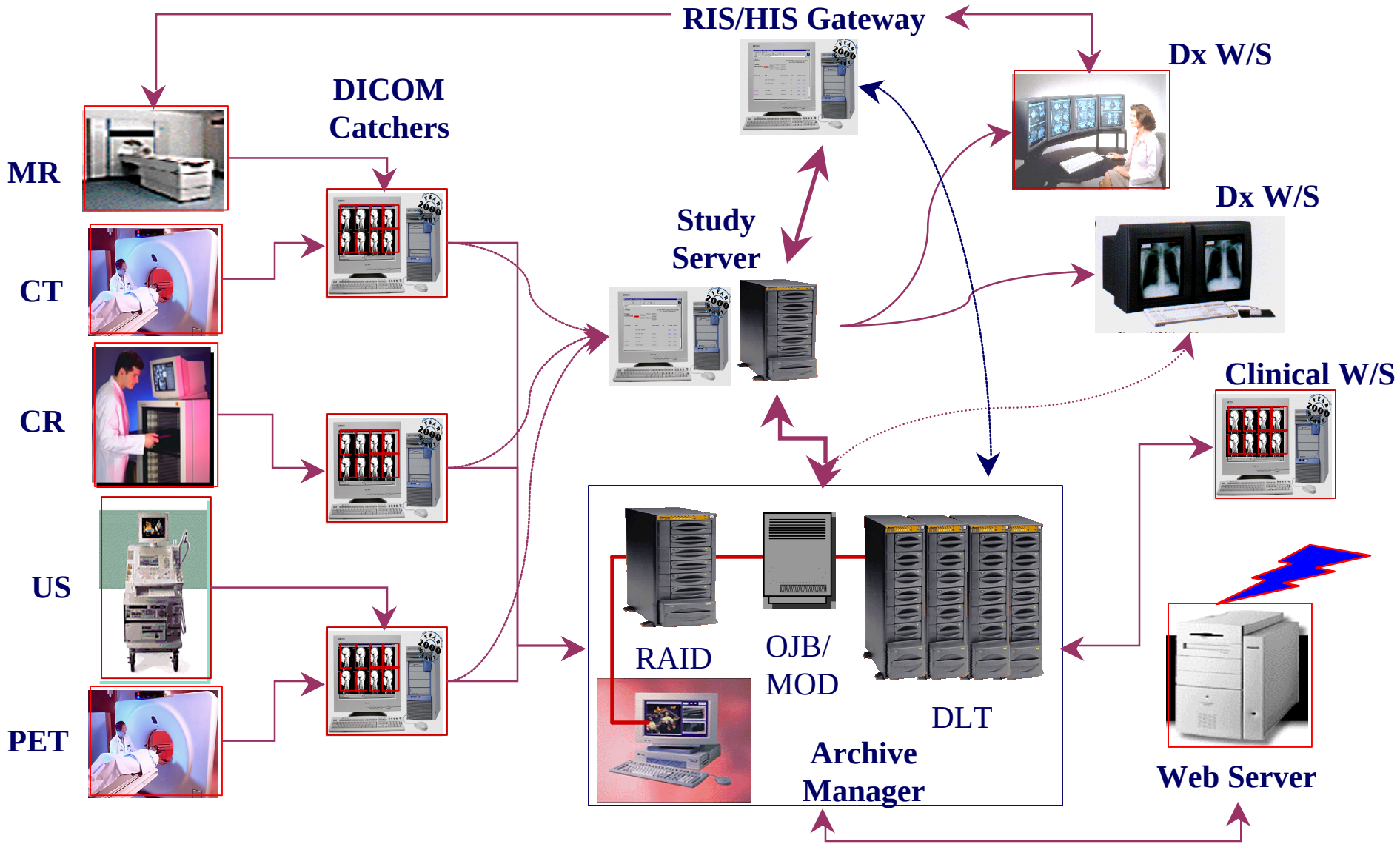
Several Film Printers

# NIH/ISP Total Imaging Workload

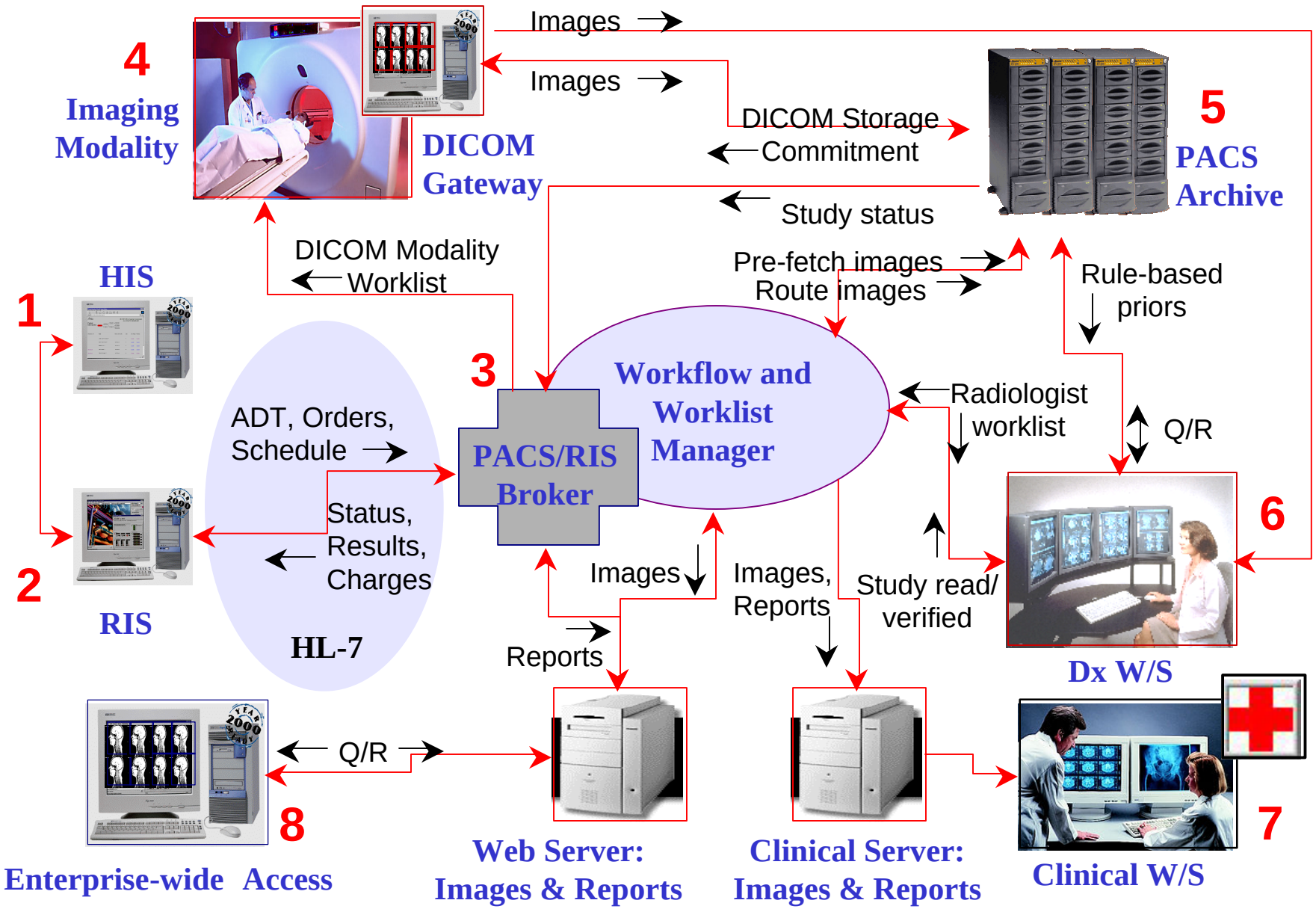
| Typical: | At peak: |
|---|---|
| 8.31 GB/day | 16.398 GB/day |
| 42.5 GB/wk | 82.3 GB/wk |
| 169.8 GB/mo | 329.2 GB/mo |
| 2037.5 GB/yr | 3950.2 GB/yr |

- Assuming each individual image slice is 0.5 MB (e.g., a single CT image slice), then we generate, network, display, interpret and archive approximately 8 million individual image slices per year.

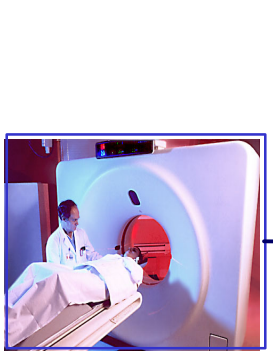
# Typical PACS Conf



# PACS/RIS/HIS Workflow



# Image Workflow and Archive Options



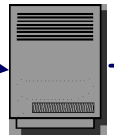
Scanner

Server

Reading Station

Tape

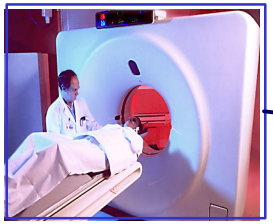
RAID



Disk

Tape

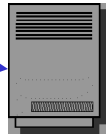
Web-server



Scanner

Server

RAID



Disk

Web-server

Net-based solution

Reading Station

# PACS: Web Solution

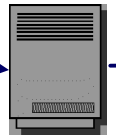
Scanner

Server

Reading Station

Tape

RAID



Disk

Tape

Push New Imgs

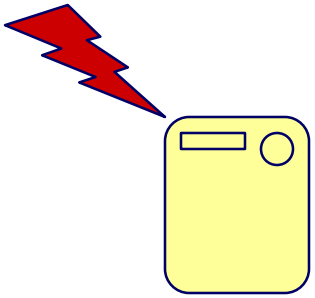
Q/R

Q/R

Physician/ Scientist

Email

Web-server



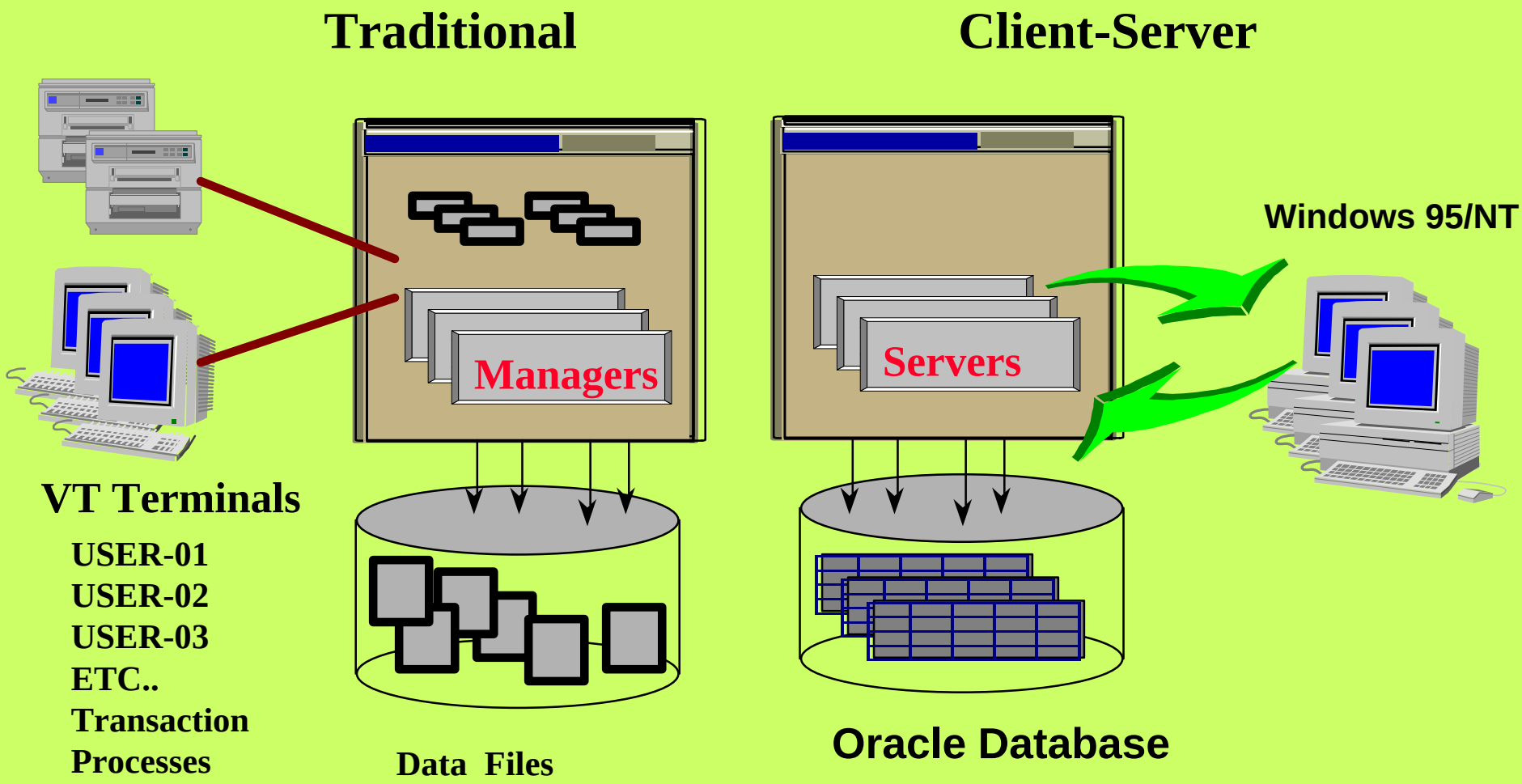
Pager

1-800-NIH BEEP

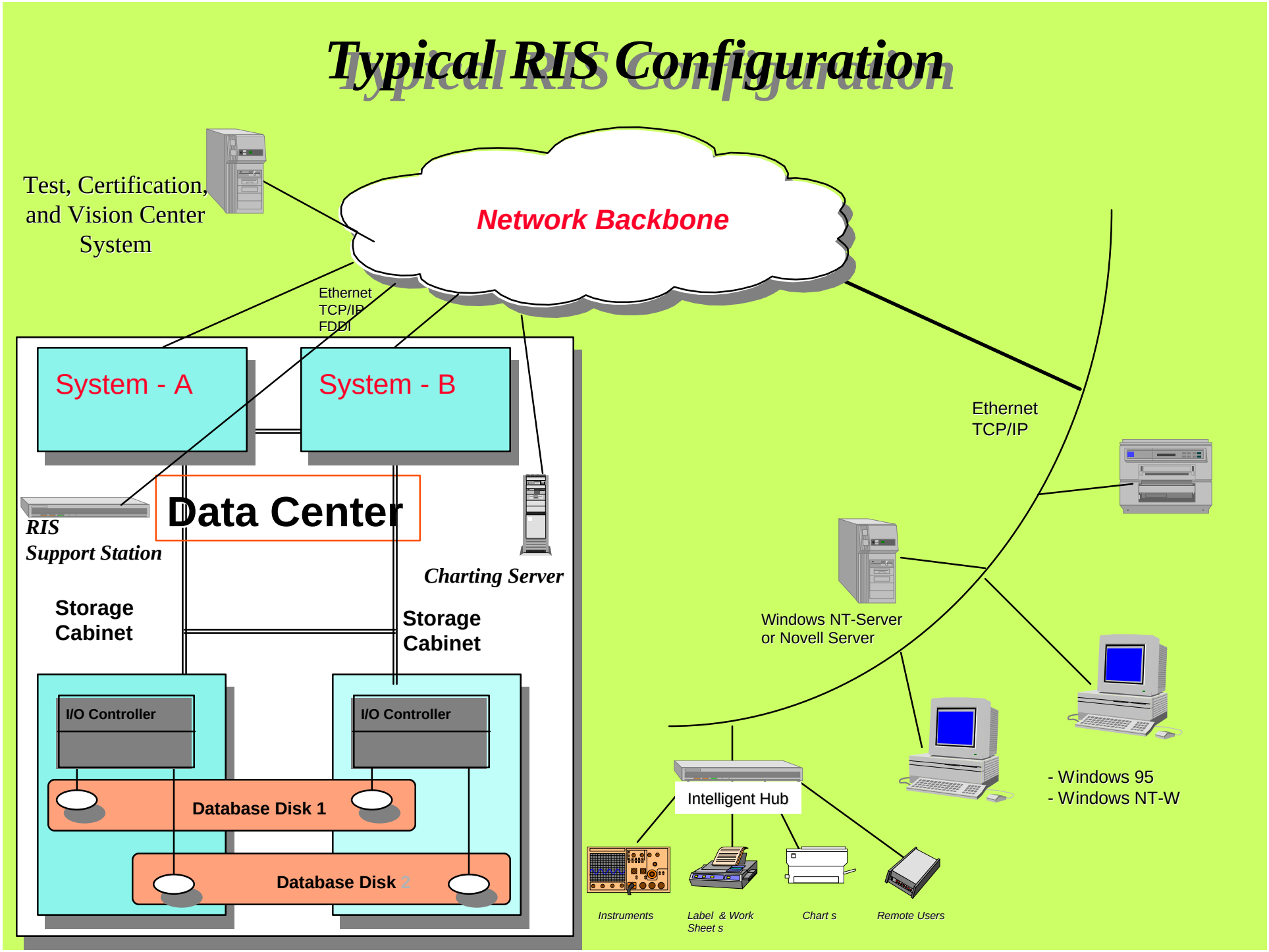
# Radiology Inf

- Provides interfaces for patient registration, ordering procedures and exams, reporting results;
- Interfaces with PACS (and HIS) via HL-7 standard;
- NT-based client-server architecture;
- Provides statistical information about the radiology department including utilization rates, types of procedures, turnaround time, radiologist/technologist productivity, costs, etc.
- Additional functionality (per NIH request): integration with researchers' databases

# Mainf vs. Client-Server System Architectures



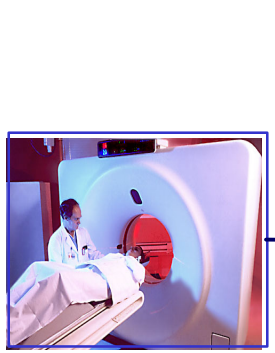
# Typical RIS Configuration



# Research Opportunities with PACS/RIS

- Film-Based vs. Filmless Radiology
  - Statistical data from RIS
  - Image parameters from PACS
- CR vs. DR, Wet vs. Dry printing
- Image Processing
  - Image quantitation, segmentation
  - Multi-modality image registration
  - Visualization: 2-D, 3-D

# PACS and Image Processing



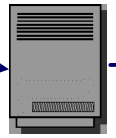
Scanner

Server

Reading Station

DLT

RAID



Disk

DLT

Web-server

| | |
|---|---|
| Image Segmentation | Synthesis of Parametric Images |
| Computational Anatomy | Data Visualization |
| Multimodality Image Registration | Image-guided surgery and treatment planning |

# Concluding Statements

- We have designed and started implementation of automated systems for acquisition, transmission, management and display of digital diagnostic images and associated text/demographic information;
- These systems are capable of improving the quality and efficiency of radiology services as well as increasing the availability of images and reports to referring clinicians;
- In addition to facilitating image management, storage, and secured data sharing, we provide a framework for improved medical image interpretation with the use of image processing tools.